

Unravelling perceptions of Eurasian beaver reintroduction in Great Britain

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International Union for the Conservation of Nature (IUCN) guidelines state that anticipated impacts must be considered in wildlife reintroduction, including the impacts on humans. Further, since reintroduction projects can be halted by resulting human–wildlife conflicts or human–human conflicts about wildlife, the perceptions of stakeholders and publics are of great importance. Eurasian beaver (*Castor fiber*) reintroduction is being debated in Great Britain at a devolved level. A decision has already been taken in Scotland to allow beavers already present to remain, while a number of reintroduction trials are taking place in England (both fenced and unfenced). There are also proposals for a reintroduction trial in Wales. We use a sub-set of results from a nationwide survey ($n = 2,759$) to identify four social areas that we propose decision-makers should consider in the debate: key stakeholder perceptions; engagement methods; attitudes towards legal protection and management responsibilities; and support for management techniques. In this paper, we investigate the complex social dimensions of wildlife reintroduction and we argue that emphasis should be placed on the need to recognise societal perceptions of potential management solutions, beyond perceptions of reintroduction itself. This is paramount in order to develop a management strategy that is more likely to garner social support and reduce potential future conflicts, should beaver reintroduction proceed.

KEYWORDS

Eurasian beaver, Great Britain, human–wildlife conflict, perceptions, reintroduction, survey

1 | INTRODUCTION

Conflicts between humans and wildlife – or “human–wildlife conflicts” – are increasing, particularly due to land use change associated with human population growth. These occur where wildlife is perceived to have undesirable impacts (e.g., economic loss or a decrease in well-being) (Nyhus, 2016). Often these are in fact human–human conflicts about wildlife, particularly when groups hold differing perceptions of management solutions (Marshall et al., 2007; Redpath et al., 2015). Human–human conflicts are often polarised, with complex debates framed as distinct opposing arguments (Redpath et al., 2013).

Wildlife reintroduction poses a unique conundrum for human–wildlife conflict theory. Reintroduction is an increasingly used conservation technique in which a species is returned to an environment in which it previously resided, often associated with ecological restoration or “rewilding” – the returning of managed land to “the wild” (Corlett, 2016). The unique conflict challenge in reintroduction (and wildlife translocations) is that conflicts are not necessarily yet present, but projects

can be halted by resultant conflict issues (Hayward et al., 2007). Conflicts have consequences for decision-making about whether to reintroduce/translocate and how to manage projects. It is therefore important to identify and engage stakeholders early in the process (IUCN/SSC, 2013). If projects proceed, they may require management strategies to prevent conflicts arising later, depending on social and ecological contexts (Decker et al., 2015; Redpath et al., 2013).

Reintroduction of the Eurasian beaver (*Castor fiber*) – here-on referred to as beaver – is under debate in Great Britain (GB) with a number of projects underway. The species is estimated to have been resident until the 16th century, when hunted to extinction by humans. Similar events occurred in Europe and reintroduction has led to a self-sustaining population across most of the beavers' historical range (Halley & Rosell, 2003; Puttock et al., 2017).

Beavers are listed on Annex IV of the European Union (EU) "Habitats Directive" (Council of the EU, 1992). Annex IV requires member states to implement protective measures for listed species (if present) and to consider reintroducing formerly native species. Beaver reintroduction is now being considered in Great Britain (GB) (distinct from the UK as there is no evidence of beaver residence in Northern Ireland (Halley & Rosell, 2003)), with decision-making devolved to the Scottish, English, and Welsh governments.

Reintroduction considerations include environmental impacts of the beavers' role as "ecosystem engineers" (organisms which cause physical environmental changes that influence ecological community structures), including tree-felling and dam-building. Beaver behaviours may provide multiple ecosystem services, defined as benefits humans obtain from ecosystems (Gaywood, 2018; Millennium Ecosystem Assessment, 2005). In particular, beavers may provide a role in natural flood management by attenuating water flows in high rainfall events (Puttock et al., 2017). However, there are potential conflicts due to perceptions among social groups of (sometimes real) negative impacts of beaver-led landscape change, including the risk of flooding productive land or potential barriers to fish migration (Kemp et al., 2011; Morzillo & Needham, 2015). Hence, much of the debate is polarised and politically sensitive (Crowley et al., 2017).

Beaver reintroduction is at various stages across GB, with devolved decision-making responsibility. In Scotland, following a licensed trial in Mid-Argyll and assessment of a population of beavers in Tayside which established following an unlicensed release/escape (Scottish Natural Heritage, 2015), the Scottish Government announced that beavers are to be allowed to remain and that they will be listed as a European Protected Species (Gaywood, 2018; Scottish Government, 2019). In England, a population of unknown origin has been licensed for a reintroduction trial in Devon (Natural England, 2015) alongside a number of fenced projects, and the UK government has included reference to "providing opportunities for reintroduction of species such as beavers" in its 25-year environmental plan (for England) (HM Government, 2018, p. 57). For Wales, a feasibility study was conducted following which the "Welsh Beaver Project" was established to propose a Welsh trial (Jones et al., 2012).

International Union for the Conservation of Nature (IUCN) and Species Survival Commission (SSC) guidelines require reintroduction projects to consider anticipated impacts, including on humans (IUCN/SSC, 2013). Additionally, in Scotland the guidelines given in the "Scottish Code for Conservation Translocations" (which are based around the IUCN/SSC guidelines) must also be considered in reintroduction decisions (National Species Reintroduction Forum, 2014). In England, a reintroduction code is to be developed which may be applicable to reintroductions in the near future (HM Government, 2018, p. 61).

This paper aims to investigate complex social dynamics in beaver reintroduction and to build a consensus as to what knowledge is needed for decision-makers and society to comprehend the impacts of reintroducing beavers across GB. We draw on a sub-set of results from a nationwide online public attitudes survey to identify and outline four social factors that must be considered by decision-makers:

1. key stakeholder perceptions;
2. engagement methods;
3. attitudes towards legal protection and management responsibilities; and
4. support for management techniques.

We recognise the study of perceptions thus far. In Scotland, varied stakeholder engagement exercises were conducted over the past 20 years, including consultation most recently on species management (Gaywood, 2018; Scottish Beaver Trial, 2014; Scottish Government, 2017; Tayside Beaver Study Group, 2015a, 2015b). In England and Wales, interviews were held with stakeholder organisations for the feasibility studies (Gurnell et al., 2009; Jones et al., 2012) and stakeholder engagement is ongoing in the beaver trials. This paper builds on this work with an approach that accounts for perceptions among both stakeholders and the public. It aims to provide a deeper understanding beyond views on impacts, quantitatively comparing perceptions across the whole of GB for the first time. We explore opinions on engagement and potential beaver management and use findings to demonstrate how the four outlined factors are relevant for reintroductions.

2 | METHODS

As beavers are likely to naturally expand their range as populations grow (Halley et al., 2012), reintroduction will have consequences throughout GB. Therefore, a national-scale survey was undertaken to meet the research aims.

2.1 | Establishing questions

Following a literature review, we undertook an exploratory interview-based study in March–April 2016 in the catchment of the “River Otter Beaver Trial.” This is the site of the English trial studying the “wild” beaver population that has established since 2007, and hence where human–beaver interactions have occurred (Crowley et al., 2017). Twelve purposively selected participants (covering the opinion spectrum recognised in the literature review) answered open-ended questions about beaver impacts and potential beaver management. We used thematic content analysis to identify themes to design the survey questions (see Data S1).

Questions were divided into five categories:

1. Knowledge of beaver ecology (detailed in section 3.3).
2. Perceptions of beaver impacts using Likert Scales – a bipolar scale in which respondents rate their answers (Allen & Seaman, 2007) – in an ordinal rating of “Very Negatively” (score 1) to “Very Positively” (score 5) on 8 impact themes.
3. Methods by which respondents felt comfortable to express views and whether they felt able to express them where it influences decision-makers.
4. Respondent views on the process of beaver reintroduction and potential beaver management.
5. Respondent details (occupation, geographical region, and the distance the respondent lives from a watercourse).

Questions were piloted internally ($n = 20$) to ensure clarity and bias avoidance.

2.2 | Sampling

We distributed the survey using the online platform “Typeform” (www.typeform.com) between 27 January and 1 March 2017, with the option for participants to request a paper copy.

We recruited participants with a “snowball” sample. This strategy identifies contacts with particular characteristics and invites them to recruit similar participants within their networks. New participants can in turn invite others, leading to a “snowballing” effect (Wasserman & Faust, 2007). A limitation is that numbers cannot be directly inferred to wider populations, but due to the topic's political sensitivity it was imperative to encompass a spectrum of views, including those of hard-to-reach groups (such as those who may be reluctant to volunteer due to political pressures or stigmas) that “snowballing” enables researchers to recruit (Sadler et al., 2010). Further, we aimed to examine attitudinal variance in response to background variables, rather than opinion prevalence.

“Snowballing” was achieved in two ways:

1. We invited 106 organisations/representatives that may have an interest in beaver reintroduction (purposively selected to cover the range of interest groups identified in preliminary work) to share the survey within their networks.
2. To capture the general public, we issued an impartial press release invitation through the University of Exeter Press Office, distancing us from media outlets. As far as we know, this appeared in 10 outlets.

We provided an optional prize draw as an incentive for participation, which took about 25 minutes.

2.3 | Analysis

In each analysis we excluded respondents who did not answer the required questions. We undertook statistical analyses using IBM SPSS Statistics 23 x64 and R i386 3.3.2 software. Results were deemed significant when $p < 0.05$.

Ordinal logistic regression analysed whether respondent background variables influenced views on overall impacts of beaver reintroduction (response variable) relative to the other survey respondents, using overall scores of the ordered Likert-scale responses as identified in the methods ($n = 2,272$). For ordered independent variable (distance resident from a

watercourse), the different categories were included within one model. For categorical independent variables (occupation, region), categories were compared to their dummy variables individually.

We used ordinal logistic regression to analyse overall impact scores (response variable) in response to the ordered independent variable of “Level of Knowledge” ($n = 2,272$), identified from answers to five multiple choice questions about beaver ecology (Data S2). Correct answers scored one point and total scores were assigned a “Level of Knowledge” category: 0 or 1 = “Little or No Knowledge” ($n = 52$); 2 or 3 = “Moderate Knowledge” ($n = 503$); 4 or 5 = “Strong Knowledge” ($n = 1,717$).

Analysis of variance (ANOVA) was utilised to test the relationship between overall impact scores and whether respondents supported the process of beaver reintroduction to GB (response variable) ($n = 2,274$). We then applied Pearson chi-square tests to assess relationships between whether respondents supported the process of beaver reintroduction to GB and the response variables: whether respondents felt able to express views where it influences decision-makers ($n = 2,685$); what level of legal protection should be applied if/where beavers are reintroduced (“Strong,” “Limited,” or “None”) ($n = 2,725$).

Finally, we used chi-square tests of independence on multiple response sets to examine relationships between: methods by which respondents felt comfortable to express views and whether or not they felt able to express views where it influences decision-makers ($n = 2,335$); views on who should take responsibility for managing beavers in practice (if anybody) and the level of legal protection respondents felt should be applied if beavers are reintroduced ($n = 2,597$); support for management techniques, aligned with *The Eurasian Beaver Handbook* (Campbell-Palmer et al., 2016); and whether respondents supported the process of beaver reintroduction ($n = 2,702$). To note, multiple response questions challenge traditional Pearson chi-square tests as the data in a contingency table are not mutually exclusive. However, with adjustments a test can be used as an approximate test for marginal association (Thomas & Decady, 2004).

2.4 | Ethics

The study was approved by the University of Exeter's Ethics Committee.

3 | RESULTS

In total, 2,759 submissions were received (including one paper copy), 52.7% of those who started the survey online or requested a paper copy. (Respondent summary data in Data S3.)

3.1 | Key stakeholder perceptions

Table 1 shows the odds ratio results of the ordinal regression analyses. Odds ratios are measures of effect to compare respondents of a group to the other respondents (in each model as outlined in the methods). Table 1 shows that in all variables there were statistical significances indicating groups that could be identified as more/less likely to score in the next level on the overall Likert scales of views on beaver impacts (i.e., have a more positive view). A sum Nagelkerke Pseudo R^2 value of 0.109–0.130 was obtained.

When looking at overall views of impacts, respondent level of knowledge appeared to influence whether a respondent was more/less likely to score in the next category on the scale. Those with “Little or No Knowledge” or “Moderate Knowledge” were significantly less likely than those with “Strong Knowledge” to obtain an overall score in the next category on the scale (i.e., less likely to have a more positive view). Those with “Little or No Knowledge” were associated with an odds ratio of 0.59:1 (95% CI, 0.35–0.99, Wald $\chi^2_{(2)} = 4.055$, $p < 0.05$) and those with “Moderate Knowledge” were associated with an odds ratio of 0.56:1 (95% CI, 0.46–0.68, Wald $\chi^2_{(2)} = 36.965$, $p < 0.001$). “Strong Knowledge” was the reference category. A Nagelkerke Pseudo R^2 value of 0.019 was obtained.

Regarding respondents' support for the process of beaver reintroduction to GB, 99.36% of respondents who had a “Very Positive” ($n = 1,094$) view of the overall impacts of beavers supported the process, with the remaining 0.64% undecided. Of respondents who were “Somewhat Positive” ($n = 848$), 95.05% supported the process, 4.72% were undecided, and 0.24% did not support it.

Of those who had a “Somewhat Negative” view ($n = 84$), 83.33% did not support reintroduction, with 15.48% undecided and 1.19% supporting the process. Of respondents who had a “Very Negative” ($n = 39$) overall view of impacts, 100% did not support reintroduction. Where overall impact views were “Neutral” ($n = 207$), 46.86% supported

TABLE 1 Ordinal regression analysis results of overall impact scores presented as odds ratios, comparing categories relative to other survey participants. Full statistics are reported for statistically significant results.

| Factor | Category | Odds ratio | Confidence interval | | Wald χ^2 | Nagelkerke Pseudo- R^2 |
|------------|------------------------------------|-------------------|---------------------|-------------|---------------|--------------------------|
| | | | Lower bound | Upper bound | | |
| Region | Not resident in GB | 1.56 | 0.89 | 2.71 | | |
| | North-West England | 1.50 ^a | 1.00 | 2.23 | 3.906 | 0.002 |
| | Yorkshire | 1.37 | 0.37 | 2.07 | | |
| | East England | 1.24 | 0.44 | 1.68 | | |
| | London | 1.21 | 0.84 | 1.74 | | |
| | North-East England | 1.05 | 0.57 | 1.93 | | |
| | East Wales | 1.02 | 0.59 | 1.62 | | |
| | Highlands & Islands | 1.00 | 0.65 | 1.53 | | |
| | South-East England | 0.99 | 0.77 | 1.27 | | |
| | West Wales & The Valleys | 0.96 | 0.60 | 1.53 | | |
| | West Midlands | 0.93 | 0.68 | 1.27 | | |
| | South-West England | 0.91 | 0.78 | 1.07 | | |
| | East Midlands | 0.87 | 0.60 | 1.24 | | |
| | South-Western Scotland | 0.79 | 0.40 | 1.55 | | |
| | North-Eastern Scotland | 0.79 | 0.33 | 1.88 | | |
| | Eastern Scotland | 0.62 ^b | 0.45 | 0.87 | 7.781 | 0.003 |
| Occupation | Arts, sport & media | 1.78 ^a | 1.07 | 2.94 | 4.985 | 0.002 |
| | Community & social service | 1.57 | 0.87 | 2.83 | | |
| | Environment, nature & wildlife | 1.46 ^c | 1.22 | 1.74 | 17.151 | 0.009 |
| | Sales | 1.36 | 0.61 | 3.03 | | |
| | Tourism | 1.31 | 0.46 | 3.78 | | |
| | Computer & mathematical | 1.25 | 0.72 | 2.19 | | |
| | Forestry & woodland management | 1.22 | 0.64 | 2.34 | | |
| | Education | 1.18 | 0.91 | 1.53 | | |
| | Other | 1.17 | 0.92 | 1.49 | | |
| | Healthcare | 1.14 | 0.76 | 1.72 | | |
| | Hospitality | 1.14 | 0.37 | 3.55 | | |
| | Business & finance | 1.06 | 0.67 | 1.66 | | |
| | Student | 1.01 | 0.74 | 1.37 | | |
| | Office & administrative support | 0.99 | 0.69 | 1.41 | | |
| | Transport | 0.89 | 0.31 | 2.59 | | |
| | Physical or Social Science | 0.88 | 0.43 | 1.79 | | |
| | Production | 0.68 | 0.22 | 2.03 | | |
| | Building & maintenance | 0.67 | 0.32 | 1.40 | | |
| | Retired | 0.59 ^c | 0.47 | 0.76 | 17.523 | 0.008 |
| | Architecture, energy & engineering | 0.59 | 0.34 | 1.01 | | |
| | Farming & agriculture | 0.15 ^c | 0.10 | 0.22 | 93.236 | 0.037 |
| | Fisheries & aquaculture | 0.10 ^c | 0.05 | 0.22 | 35.896 | 0.015 |

(Continues)

TABLE 1 (Continued)

| | | | Confidence interval | | | |
|---------------------------|------------------------------|--------------------|---------------------|-------------|---------------|--------------------------|
| Factor | Category | Odds ratio | Lower bound | Upper bound | Wald χ^2 | Nagelkerke Pseudo- R^2 |
| Distance from watercourse | Property extends to/includes | 0.71 ^a | 0.55 | 0.92 | 6.474 | – |
| | <50 m | 0.86 | 0.68 | 1.08 | | |
| | 50–100 m | 0.89 | 0.80 | 1.21 | | |
| | >100 m | Reference category | | | Model: 0.003 | |

^a $p < 0.05$; ^b $p < 0.01$; ^c $p < 0.001$.

reintroduction, 17.87% did not, and 35.37% were undecided. These results were statistically significant ($F_{1,4} = 2,611.1$, $p < 0.001$, $r^2 = 0.5349$).

3.2 | Engagement methods

When asked whether respondents felt able to express views where it influences decision-makers, a higher number answered “No” ($n = 1,617$) than “Yes” ($n = 1,068$). There was a significant interaction between these answers and whether respondents supported the process of beaver reintroduction ($\chi^2 = 28.542$, $df = 2$, $p < 0.001$). Of those who supported the process ($n = 2,319$), 41.74% felt able to express views, whereas 58.26% did not. Of those who did not support the process ($n = 198$), 29.80% felt able to express views, whereas 70.20% did not. Of those who were “Undecided” ($n = 168$), 24.40% felt able to express views, whereas 75.60% did not.

We found a significant interaction between whether respondents felt able to express views where it influences decision-makers and the methods by which they would feel comfortable to express views ($\chi^2 = 555.090$, $df = 10$, $p < 0.001$). A higher percentage felt comfortable to use each method if they felt able to express views than if they did not (Figure 1). In both groups digital channels (social media, organisation website, email) and word of mouth were most selected. All methods (excluding “Other”) were selected by >10% of respondents in each group.

3.3 | Attitudes towards legal protection and management responsibilities

Where respondents supported reintroduction ($n = 2,356$) the dominant view was that beavers should be given “Strong” legal protection (83.28%), followed by “Limited” (16.43%), then “None” (0.30%). Where respondents did not support reintroduction ($n = 199$) the dominant view was “None” (60.30%), followed by “Limited” (32.66%), then “Strong” (7.04%). “Undecided” respondents ($n = 170$) dominantly supported “Limited” legal protection (50.59%), followed by “Strong” (40.59%), then “None” (8.82%). These interactions were statistically significant ($\chi^2 = 1,555.1$, $df = 4$, $p < 0.001$).

We found a significant relationship between which bodies respondents felt should be responsible for management practice and the level of legal protection they felt should be applied if beavers are reintroduced ($\chi^2 = 1,741.036$, $df = 30$, $p < 0.001$). Among respondents who felt there should be “Strong” or “Limited” protection, the dominant view was that management practice was the responsibility of an environmental charity/organisation, followed by a government body. For respondents who felt there should be no legal protection, the dominant view was that responsibility should be with individuals/landowners, followed by a government body. “No Management Will Be Necessary” was least supported in all groups (excluding “Other”) (Figure 2).

3.4 | Support for management techniques

We found a significant relationship between support for management techniques and whether respondents supported the process of beaver reintroduction ($\chi^2 = 1,741.036$, $df = 30$, $p < 0.001$). Respondents who supported reintroduction primarily supported education (to address misinformation or how to manage beavers), followed by paying landowners to host beavers on their land. Those who did not support reintroduction primarily supported compensation for losses, followed by population control by culling. Undecided respondents primarily supported education, followed by compensation for losses/tree protection. “No Management Will Be Necessary” was least supported in all groups (excluding “Other”) (Figure 3).

4 | DISCUSSION

4.1 | Key stakeholder perceptions

Identifying stakeholders is important in policy decisions and herein it is shown that this must encompass the spectrum of views, including proponents and opponents. Table 1 demonstrates differences of statistical significance that could implicate differing levels of potential conflicts. In particular, and in line with literature from where beavers are present elsewhere (see Introduction), respondents whose occupations were in “Farming & Agriculture” or “Fisheries & Aquaculture” were significantly less likely to have a more positive view of beaver impacts, as were those who were “Retired,” respondents whose property extends up to/includes a watercourse, and residents of Eastern Scotland. Conversely, those whose occupation was in “Environment, Nature & Wildlife” or “Arts, Sport & Media” were significantly more likely to be more positive, as were residents of North-West England. Between these groups there is an increased risk of polarisation and conflict.

There were differences in respondent levels of knowledge. Those with “Strong Knowledge” were more likely to have a more positive view of beaver impacts. This implicates a need for education and addressing misinformation, and demonstrates that awareness of participant knowledge is necessary for informed decision-making, which would also have been true if the reverse trend had been found.

4.2 | Engagement methods

Perceptions need particular acknowledgement during research/trial phases of projects when beaver reintroduction impacts need full consideration (IUCN/SSC, 2013). All stakeholders and publics therefore need opportunities to express views where it may influence decision-makers. However, this research indicated the majority of respondents who answered

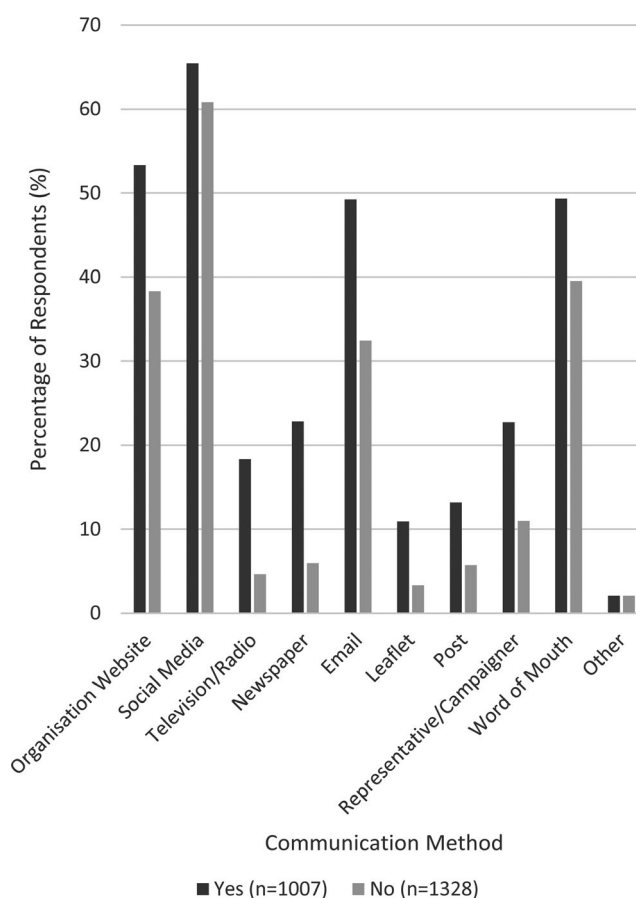


FIGURE 1 Percentage of respondents who felt comfortable expressing views through various communication channels as asked in a multiple response question, expressed in relation to whether respondents felt able to express views where it influences decision-makers – as denoted by the key.

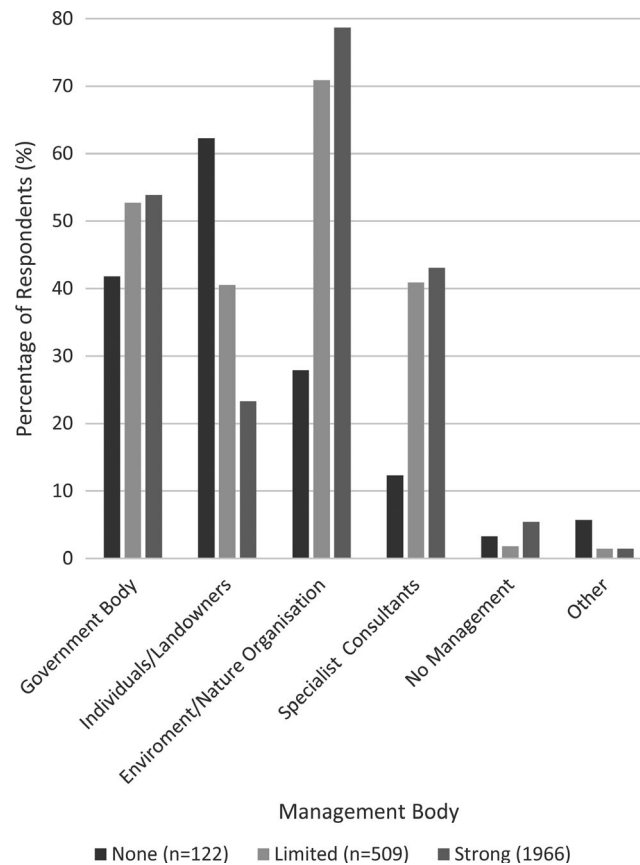


FIGURE 2 Respondents' views on who should take responsibility for management practice from a multiple response question, expressed in relation to the respondents' views on the level of legal protection that is required – as denoted by the key.

(60.22%) felt unable to do so. Although true in all groups, the margin was wider for those who did not support beaver reintroduction or were undecided than for those who did. The IUCN guidelines state that mechanisms for engagement “should be established well in advance of any release” (IUCN/SSC, 2013, p. 11) and that “participation in monitoring may be a practical means of engaging ... and can be used to assess attitudes” (IUCN/SSC, 2013, p. 21). Thus, to meet the guidelines, the sense of inability to express opinions will need to be addressed throughout reintroduction processes. It should be noted, however, that methods and opportunities to engage will vary between projects. For example, there were numerous engagement studies before and during the Scottish Beaver Trial, but opportunities to engage pre-release were not present in the unlicensed release/escape in Tayside.

Furthermore, there were differences in specific methods whereby respondents felt comfortable to express views (Figure 1). While accounting for resource limitation, maximum opportunity will mean providing multiple channels for opinion expression. (To note, this survey was primarily online, which could have influenced this result, despite the paper copy option.) Due to the debate's complexities, it is likely that decisions will receive a mixture of support and opposition, particularly between groups identified as more/less likely to view beaver impacts positively, but greater support may be gathered if there is opportunity for view expression and decision-makers should provide evidence to demonstrate how opinions have been recognised.

4.3 | Attitudes towards legal protection and management responsibilities

In Scotland, a decision has been indicated on beaver reintroduction. In England and Wales, decisions are due after trial phases. The nature of these decisions are forward-thinking and, if beaver reintroductions progress, the question of species management needs early consideration. Indeed, results demonstrated support for some form of management; in Figures 2 and 3, fewest respondents supported “No Management.”

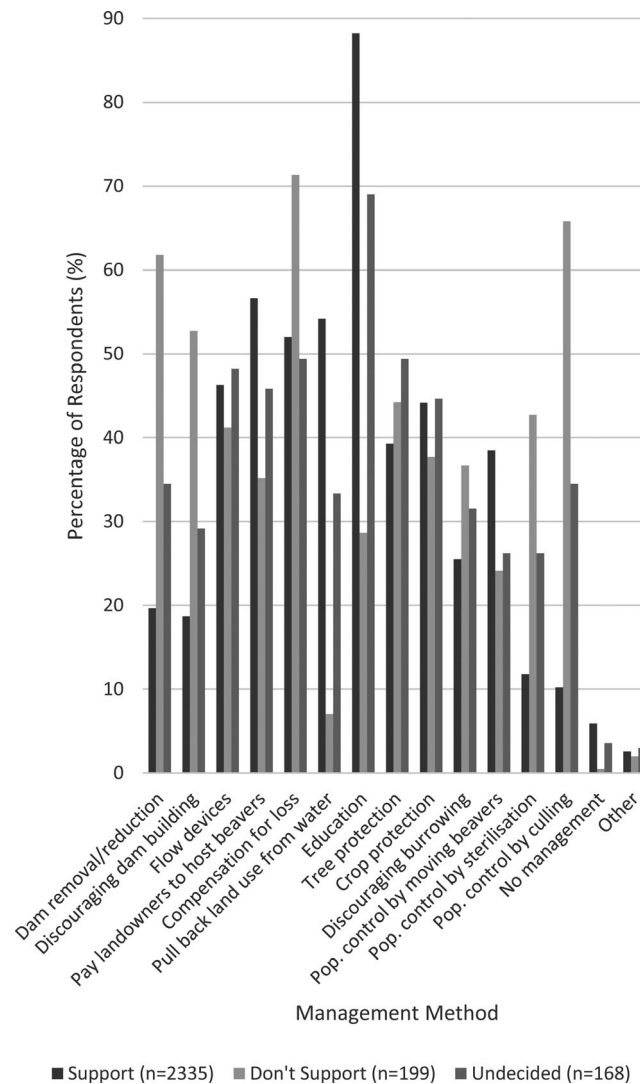


FIGURE 3 Respondents' support for management techniques expressed in relation to whether they support the process of beaver reintroduction to Great Britain – as denoted by the key.

There is opportunity to be proactive and collectively consider strategies from the outset, beginning with decisions on legal protection. These are devolved decisions so specific applications of legal protection will vary where differing policies apply. It is appropriate though to recognise that the application of one of these policies is currently uncertain; the future of the “Habitats Directive” (on which beavers are listed) in GB is unclear, due to recent moves to leave the EU (“Brexit”). It is likely that post-“Brexit” in 2020 (coinciding with the completion of the Devon trial) there will be better indication as to how European species protection policies will be applied across GB.

Regardless of these variables, and due to perceived beaver impacts, strategic decisions are needed on what management should occur – particularly by whom, as this will be affected by any level of legal protection applied, whether under current or new policies. This should be accessibly outlined at the earliest opportunity to manage expectations and reduce conflicts (Decker et al., 2015).

4.4 | Support for management techniques

Although consideration of the effectiveness and ecological implications of beaver management techniques is required, social aspects also need to be considered (Decker et al., 2015). Here there was variance in support for techniques (Figure 3). We argue that understanding these differences is critical to determining an approach most likely to garner public support, in particular between groups identified as having a more/less positive view of beaver impacts (section 4.4). While considering

social and environmental contexts (Decker et al., 2015), emphasis needs to be placed on understanding attitudes towards management if selected techniques are to be deemed socially acceptable, rather than risk polarised human–human conflict.

4.5 | Research recommendation

Financial implications of management are an important consideration and for some a source of concern, as demonstrated by an anonymous quote received during this research: “if beavers stay in the future ... then it's going to be a major cost for somebody to pick up.” Research into the socio-economics of beaver reintroduction, both potential costs and benefits, has been undertaken to some degree, noting particularly the socio-economic reports on the Scottish Beaver Trial and Tayside Beaver population (Moran & Lewis, 2014; Scottish Natural Heritage, 2015, Tayside Beaver Study Group, 2015a, 2015b). Research is ongoing, particularly in England and Wales, where beaver reintroduction events are more recent. It is recommended that this research continues to give greater understanding of potential conflicts, as well as potential Ecosystem Service benefits. This will further help to identify whether perceived impacts are “real” (Messmer, 2000). However, it should be recognised that qualitative study is important also; economics are not of unanimous concern due to differences in ethical values, demonstrated by a survey participant: “Economics should not be a significant factor in wildlife conservation.”

5 | CONCLUSIONS

By exploring four social areas of focus, this research has demonstrated significant social implications of beaver reintroduction needing full recognition (alongside ecological knowledge) in pragmatic decision-making. This study found differences between social groups that need accounting for in informed, socially acceptable decisions that prevent polarised conflicts from developing. This will require enabling stakeholders and the public opportunity to express opinions without judgement.

This paper argues particularly that decision-makers need to recognise perceptions about potential legal protection and beaver management techniques, beyond those simply of reintroduction itself. Wildlife management decisions are often made reactively to conflicts that occur, yet in reintroduction these decisions can be made proactively before conflicts arise. This task should be viewed as an opportunity for tackling challenges head-on while developing an optimal strategic approach, one that aims to support negatively affected parties while allowing opportunity to maximise potential benefits (Messmer, 2000). Although challenging, decisions that account for societal attitudes will be more likely to garner public support and reduce possible future human–wildlife and human–human conflicts.

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DATA ACCESSIBILITY

Due to ethical concerns resulting from the permissions given by participants for use of data in this research, supporting data cannot be made openly available. Data are held by the corresponding author.

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REFERENCES

- Allen, E. I., & Seaman, C. A. (2007). Likert scales and data analyses. *Quality Progress*, 40, 64–65.
- Campbell-Palmer, R., Gow, D., Campbell, R., Dickinson, H., Girling, S., Gurnell, J., & Rosell, F. (2016). *The Eurasian Beaver Handbook, ecology and management of castor fiber*. Exeter, UK: Pelagic Publishing.
- Corlett, R. T. (2016). Restoration, reintroduction, and rewilding in a changing world. *Trends in Ecology and Evolution*, 31, 453–462. <https://doi.org/10.1016/j.tree.2016.02.017>
- Council of the EU. (1992). *Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora*. Brussels, Belgium: Council of the EU.
- Crowley, S. L., Hinchcliffe, S., & McDonald, R. A. (2017). Nonhuman citizens on trial: The ecological politics of a beaver reintroduction. *Environment and Planning A*, 49, 1846–1866. <https://doi.org/10.1177/0308518X17705133>
- Decker, D., Smith, C., Forstchen, A., Hare, D., Pomeranz, E., Doyle-Capitman, C., Schuler, K., & Organ, J. (2015). Governance principles for wildlife conservation in the 21st century. *Conservation Letters*, 9, 290–295. <https://doi.org/10.1111/conl.12211>
- Gaywood, M. (2018). Reintroducing the Eurasian beaver *Castor fiber* to Scotland. *Mammal Review*, 48, 48–61. <https://doi.org/10.1111/mam.12113>
- Gurnell, J., Gurnell, A. M., Demeritt, D., Lurz, P. W. W., Shirley, M. D. F., Rushton, S. P., Faulkes, C. G., Nobert, S., & Hare, E. J. (2009). The feasibility and acceptability of reintroducing the European beaver to England. England: Natural England and People's Trust for Endangered Species.
- Halley, D. J., & Rosell, F. (2003). Population and distribution of European beavers (*Castor fiber*). *Lutra*, 46, 91–101.
- Halley, D., Rosell, F., & Saveljev, A. (2012). Population and distribution of European beavers (*Castor fiber*). *Baltic Forestry*, 18, 168–175.
- Hayward, M. W., Adendorff, J., O'Brien, J., Sholto-Douglas, A., Bissett, C., Moolman, L. C., Bean, P., Fogarty, A., Howarth, D., Slater, R., & Kerley, G. I. H. (2007). Practical considerations for the reintroduction of large, terrestrial, mammalian predators based on reintroductions to South Africa's Eastern Cape Province. *The Open Conservation Biology Journal*, 1, 1–11. <https://doi.org/10.2174/1874839200701010001>
- HM Government. (2018). *A green future: Our 25 year plan to improve the environment*. London, UK: Crown Copyright.
- IUCN/SSC. (2013). Guidelines for reintroductions and other conservation translocations. Version 1.0. Switzerland: International Union for the Conservation of Nature and Species Survival Commission.
- Jones, A. C. L., Halley, D. J., Gow, D., Branscombe, J., & Aykroyd, T. (2012). *Welsh Beaver Assessment Initiative Report: An investigation into the feasibility of reintroducing European Beaver (Castor fiber) to Wales*. Cardiff, UK: Wildlife Trusts Wales.
- Kemp, P. S., Worthington, T. A., Langford, T. E. L., Tree, A. R. J., & Gaywood, M. J. (2011). Qualitative and quantitative effects of reintroduced beavers on stream fish. *Fish and Fisheries*, 13, 158–181. <https://doi.org/10.1111/j.1467-2979.2011.00421.x>
- Marshall, K., White, R., & Fischer, A. (2007). Conflicts between humans over wildlife management: On the diversity of stakeholder attitudes and implications for conflict management. *Biodiversity and Conservation*, 16, 3129–3146. <https://doi.org/10.1007/s10531-007-9167-5>
- Messmer, T. A. (2000). The emergence of human-wildlife conflict management: Turning challenges into opportunities. *International Biodeterioration and Biodegradation*, 45, 97–102. [https://doi.org/10.1016/S0964-8305\(00\)00045-7](https://doi.org/10.1016/S0964-8305(00)00045-7)
- Millennium Ecosystem Assessment. (2005). *Ecosystems and human well-being: Synthesis*. Washington, DC: Island Press.
- Moran, D., & Lewis, A. R. (2014). The Scottish beaver trial: Socio-economic monitoring, final report. Inverness, UK: Scottish Natural Heritage Commissioned Report No. 799.
- Morzillo, A. T., & Needham, M. D. (2015). Landowner incentives and normative tolerances for managing beaver impacts. *Human Dimensions of Wildlife*, 20, 514–530. <https://doi.org/10.1080/10871209.2015.1083062>
- National Species Reintroduction Forum. (2014). *The Scottish code for conservation translocations*. Inverness, UK: Scottish Natural Heritage.
- Natural England. (2015). *LICENCE – Release of non-native species and those listed under Schedule 9; Devon Wildlife Trust*. Sheffield, UK: Natural England.
- Nyhus, P. J. (2016). Human-wildlife conflict and coexistence. *Annual Review of Environment and Resources*, 41, 143–171. <https://doi.org/10.1146/annurev-environ-110615-085634>
- Puttock, A., Graham, H. A., Cunliffe, A. M., Elliott, M., & Brazier, R. E. (2017). Eurasian beaver activity increases water storage, attenuates flow and mitigates diffuse pollution from intensively-managed grasslands. *Science of the Total Environment*, 576, 430–443. <https://doi.org/10.1016/j.scitotenv.2016.10.122>
- Redpath, S. M., Bhatia, S., & Young, J. (2015). Tilting at wildlife: Reconsidering human-wildlife conflict. *Oryx*, 49, 222–225. <https://doi.org/10.1017/S0030605314000799>
- Redpath, S. M., Young, J., Evelyn, A., Adams, W. M., Sutherland, W. J., Whitehouse, A., & Gutiérrez, R. J. (2013). Understanding and managing conservation conflicts. *Trends in Ecology and Evolution*, 28, 100–109. <https://doi.org/10.1016/j.tree.2012.08.021>
- Sadler, G. R., Lee, H.-C., Lim, R. S.-H., & Fullerton, J. (2010). Recruitment of hard to reach population subgroups via adaptations of the snowball sampling strategy. *Nursing and Health Sciences*, 12, 369–374. <https://doi.org/10.1111/j.1442-2018.2010.00541.x>
- Scottish Beaver Trial. (2014). *The Scottish Beaver Trial: The story of Britain's first licensed release into the wild. Final Report*. Edinburgh, UK: Scottish Wildlife Trust & Royal Zoological Society of Scotland.
- Scottish Government. (2017). A consultation on the beavers in Scotland strategic environmental assessment environmental report. Retrieved from <https://consult.gov.scot/forestry/beavers-in-scotland/>
- Scottish Government. (2019, February 23). Beavers given protected status. Retrieved from <https://news.gov.scot/news/beavers-given-protected-status>

- Scottish Natural Heritage. (2015). *Beavers in Scotland: A report to the Scottish government*. Inverness, UK: Scottish Natural Heritage.
- Tayside Beaver Study Group. (2015a). Tayside beaver study group: Final report.
- Tayside Beaver Study Group. (2015b). Tayside beaver socio-economic impact study. Inverness, UK: Scottish Natural Heritage Commissioned Report No. 805.
- Thomas, R. D., & Decady, Y. J. (2004). Testing for association using multiple response survey data: Approximate procedures based on the Rao-Scott approach. *International Journal of Testing*, 4, 43–59. https://doi.org/10.1207/s15327574ijt0401_3
- Wasserman, S., & Faust, K. (2007). *Social network analysis: Methods and applications*. New York, NY: Cambridge University Press.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Data S1. Finalised survey (including information for participants).

Data S2. Respondent answers to multiple choice beaver ecology questions.

Data S3. Summary respondent data.

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